DOE Accident Investigation Program Lessons Learned

Based on the July 28, 1998, Carbon Dioxide Release at INEEL

Lesson Learned Statement:

Design and installation irregularities in total flooding carbon dioxide (CO_2) fire suppression systems can lead to a sudden and unexpected lethal discharge of CO_2.

The unexpected activation on July 28 of the high pressure, carbon dioxide fire suppression system in Building 648 at the Idaho National Environmental Engineering Laboratory (INEEL) provided a tragic reminder of the need to hasten the implementation of Integrated Safety Management (ISM). Within seconds, 15 workers found themselves struggling to escape the building, while confronting a potentially lethal and disorienting atmosphere under near zero visibility. The accident caused one fatality, several life-threatening injuries, and a significant risk to the safety of initial rescuers.

The accident was preventable. In many respects, circumstances contributing to the accident were in direct contrast to the principles of ISM. These circumstances included the failure to perform hazard analysis, implement work controls, establish effective hazard controls, or respond to a worker's safety concern. Other contributors included a faulty system design, the continued use of carbon dioxide following reactor shutdown, the failure to install an isolation device, and the failure to train workers on carbon dioxide hazards, alarms, and emergency response.

Design and Installation:

On July 28, 1998, the automatic, total flooding, high pressure CO_2 fire suppression system that was electronically disabled discharged unexpectedly as workers deenergized an electrical distribution system at INEEL's Engineering Test Reactor facility. As workers opened the main feeder breakers to the electrical buses, an electrical power transient activated, releasing circuits in the Notifier Model AFP-200 microprocessor-based fire alarm control panel. The activation caused the spring-operated control valve solenoids to open and release CO_2 into the occupied space without warning. Fire alarm panel testing by the vendor has shown that a loss of AC power or AC voltage transient can activate the fire panel output circuit, which could culminate in a CO_2 discharge.

Analysis:

The microprocessor-based pre-discharge alarm (set for a 30-second delay) did not function to warn workers of the impending CO_2 discharge. Additionally, a supplemental pre-discharge device installed at the piping manifold (pneumatic discharge delay) was not connected to appropriate feedback equipment and it too failed to warn occupants. This feedback equipment was omitted at the time of original CO_2 system installation in 1971. Had an inspection of the system taken place prior to the 1997 CO_2 control system upgrades, designers would have identified an installation inconsistent with the current National Fire Alarm Code requirement that calls for an appropriate means to initiate an alarm signal upon system operation. Furthermore, system modifications completed in 1997 did not include installation of a positive means for isolating the CO_2 system. National Fire Protection Association standards require a backup alarm to alert personnel prior to a discharge of CO_2 and Occupational Safety and Health Administration standards require a positive isolation device capable of being locked out.

Recommended Actions:

All automatic actuating CO_2 fire suppression systems should be evaluated to ensure they are still required (e.g. that the need for and benefits of the system continues to exceed the potential hazard to human health, considering changing facility missions, source terms, and public risk) and, if required, that:

1. The system is designed and installed properly (i.e., required CO_2 header pressure switches and feedback loop to alarm panel are in place).
2. Positive isolation devices are present or installed during the first major system modification and capable of being physically locked out.
3. Design and modification of the CO_2 fire suppression systems are subject to an adequate independent review and quality assurance.

References:

1. Type A Accident Investigation Board Report of the July 28, 1998, Fatality and Multiple Injuries Resulting from Release of Carbon Dioxide at Building 648,Test Reactor Area Idaho National Engineering and Environmental Laboratory
2. Title 29, Code of federal Regulations, Part 1910, *Occupational Safety and Health Standards*, Subpart J, *General Environmental Controls*, and Subpart L, *Fire Protection*
3. National Fire Protection Association Standard 12, *Carbon Dioxide Extinguishing Systems*
4. National Fire Protection Association Standard 72, *National Fire Alarm Code*

Point of Contact:

For additional information, contact James Bisker, EH-51, via email at jim.bisker@hq.doe.gov, or via telephone at 301-9903-6542.